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Abstract

NON PERIODIC LATTICE WITH OPTIMUM K_{eff} VALUE AND NEGATIVE TEMPERATURE COEFFICIENT

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It is well known that the under-moderation necessary to obtain a negative temperature coefficient in a light water reactor is an economic waste. This inconvenience is remedied to a certain extent by the use of a multizone core. The authors propose to use a non-periodic lattice in which the uranium rods are disposed in concentric circles. The number of rods used in each circle is chosen so as to obtain a maximum K_{eff} value with a negative temperature coefficient, the total number of rods being constant.

The division into cylindrical cells caracterises this type of lattice in the following way : let circle "index k" have a radius R_k. The delimitation of cell index k will be known by the radii :

$$\frac{R_k + R_{k-1}}{2} \qquad \text{and} \qquad \frac{R_{k+1} + R_k}{2}$$

The coefficient of uranium concentration is :

$$g = \frac{\text{Uranium volume in one cell}}{\text{Total volume of the cell}}$$

and this coefficient caracterises each cell.

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The role of one cell can be compared to the role of one zone in a multizone reactor. To study the reactivity of a lattice as a function of the spatial distribution g (r) of the concentration coefficient, the authors use the theory of active and passive surfaces. This method, derived from the "Small Source Theory", considers the uranium rods as surface elements. The diffusion theory applies to the pure water placed between these surface elements, while the absorbing and fissile properties of uranium are taken into account by boundary conditions. The results of experiments with a subcritical assembly using slightly enriched uranium oxyde and light water confirm the theory. The temperature coefficient is determined by experiments at 20° C and 80° C. These measurements permit the establishment of the neutron balance and the deduction of the effective multiplication coefficient.

This study shows that it is possible to obtain a higher multiplication coefficient and a more uniform flux distribution in a non periodic lattice than in a regular under-moderated lattice, all at the same time conserving a negative temperature coefficient.